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**A COMBAT SEARCH AND RESCUE (CSAR) ROLE FOR THE CV-22:
IT'S COMING, GET READY**

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Executive Summary**Title: A COMBAT SEARCH AND RESCUE (CSAR) ROLE FOR THE CV-22:****IT'S COMING, GET READY****Author:** Major John Groves, United States Air Force

Thesis: A CSAR role for the V-22, particularly for CV-22 squadrons within Air Force Special Operations Command (AFSOC), is imminent. Leaders within the V-22 community should embrace this challenge, recognize training opportunities and develop key relationships required for successful CSAR operations.

Discussion: V-22 units are gaining operational capacity in an environment where Joint Force Commanders thirst for Personnel Recovery capability. The Personnel Recovery mission, and particularly Combat Search and Rescue, traditionally falls to Special Operations Air Forces. Air Force Rescue units continue to grow in capability but have limitations. V-22 is uniquely capable of performing the CSAR mission, and will be the best platform available in many future environments where PR is required.

- **Development of the V-22: From Troubled Start to Combat Employment:** Despite 27 years of rocky development, the V-22 has reached effective combat capability
- **The CSAR-X/Personnel Rescue Vehicle competition:** Bell-Boeing withdrew their V-22 from contention for the Air Force's replacement for the HH-60 Pave Hawk Rescue helicopter. This does not mean the V-22 will not perform PR or CSAR.
- **Evolution of the PR/CSAR mission:** The CSAR mission arguably reached its pinnacle in Vietnam and has supported a strong culture ever since. Air Force Rescue has grown steadily in capability, although SOF have traditionally performed CSAR missions through recent history. Air Force Rescue suffers from several issues that limit its effectiveness: AF Rescue units are often not present when forces need PR, and the CSAR mission itself wears out forces by dedicating them to long periods of inactivity.
- **Current PR/CSAR Doctrine:** PR is a joint responsibility. Each of the services bears a responsibility to protect its forces. Each service brings a unique capability to joint PR.
- **A CSAR Role for the V-22:** The V-22 is particularly suited for the PR/CSAR role. Notably, the aircraft exemplifies superior speed and range. Survivability remains an important issue. Air Force CSAR assets, though well equipped and dedicated to PR and CSAR, cannot adequately protect every American soldier, sailor, and airman in danger of becoming isolated. Marines and SOF often operate autonomously. Within SOCOM, AFSOC forces traditionally and doctrinally provide CSAR capability.
- **Recommendations:** Leaders on the V-22 community, particularly AFSOC, should:

- Participate in **peacetime Search and Rescue** missions
- Integrate into military **CSAR exercises**
- Pursue a **role in the Personnel Recovery Coordination Cell (PRCC)**
- Build **training relationships** with other members of the CSAR Task Force
- Seek **integration with similar organizations**, especially linking the Air Force and Marine Corps V-22 communities.

Conclusion: Leaders within the V-22 community stand at the center of a confluence of forces that will drive employment of the tilt rotor aircraft towards CSAR missions. Joint Force Commanders demand an effective PR capability to hedge against the moral and strategic cost of a captured airman or an isolated soldier. The V-22 offers the capability to reach quickly and deeply into denied territory; arguably better than any other rescue system. Because V-22s accompany Marines and SOF, they will be the first to deploy during major combat operations. Likewise, when Marines and SOF deploy for small operations, their organic V-22s may be the only vertical-lift assets available. Within AFSOC, CV-22 operators inherit a proud culture for CSAR with roots in Vietnam. The command has a long tradition of CSAR service to the JFC and the C/JFACC, as well as a doctrinal responsibility to SOCOM. For their part, the dedicated Air Force Rescue units cannot adequately protect every soldier, sailor, and airman in danger of becoming isolated. Personnel Recovery is, doctrinally and necessarily, a joint responsibility and commanders must ultimately leverage the unique capabilities contained in their particular force to insure the protection of their troops. In many cases, the V-22 will be the Joint Force Commander's best or only CSAR option. Leaders within the V-22 community should embrace this challenge, recognize training opportunities and develop key relationships required for successful CSAR operations.

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Preface

This paper addresses the future role of the V-22 in Combat Search and Rescue (CSAR) Operations. Because I am an Air Force Special Operations pilot scheduled to fly the Air Force's CV-22, I wanted to take a look at the environment I am about to enter. CSAR provides an interesting background; it connects all of the services but is particularly Air Force and Special Operations Forces (SOF)-centric. Although CSAR is doctrinally just one category of Personnel Recovery (PR), the acronym evokes a rich history of bold helicopter missions into hostile territory. CSAR encapsulates the noble American belief that we will never leave a man behind, our willingness to expend considerable resources to protect our forces, and our fears of what would happen politically if we failed to do so.

The V-22 lies at the confluence of many threads. In particular, I examined Air Force Special Operations Command's (AFSOC) development of the CV-22, the Marines' fielding of the MV-22, the emergence of CSAR doctrine, the history of CSAR, and the Air Force's acquisition of the CSAR-X. This paper represents a snapshot in time; there is still a lot to be written about the V-22 and Personnel Recovery. My placement at Marine Command and Staff College granted me a unique perspective. Based on my geography, I was able to consult with peers at the Pentagon and the Marine Corps, as well as the Special Operations community. I hope this paper benefits from that synergy. I would particularly like to thank Dr. John Gordon, LtCol Mike Hargis, Major Tom Kunkler, Major Joseph Michalek, Major Aaron Orr, Captain Paul Alexander, Captain Jim Peterson, and CMSgt(ret) Tom Green.

Introduction

At the outset of Operation Allied Force in Kosovo in 1999, General Wesley Clark established three measures of merit for the air campaign. Of the three, his highest priority was “not to lose any aircraft, or at least minimize the loss of aircraft.”¹ Arguably, there are few things commanders fear more than an American pilot or soldier being captured. According to Joint Publication 3-50, the military’s overarching document on personnel recovery (PR),

Preserving the lives of those participating in a US-sponsored activity or mission is one of the highest priorities of the Department of Defense (DOD). Personnel Recovery is the sum of military, diplomatic, and civil efforts to prepare for and execute the recovery and reintegration of isolated personnel.²

Doctrinally, PR is a joint responsibility. All services bear a responsibility to ensure the safety of their members and contribute capabilities to help the Joint Force Commander (JFC) protect and recover his assigned forces.³

For high risk rescue operations into denied territory, CSAR (Combat Search and Rescue) is often the JFC’s preferred PR option. According to the Air Force, CSAR is the “method of choice for accomplishing the [PR] task in uncertain, denied, or hostile environments.”⁴ While the Navy prepares helicopter crews to perform CSAR, and the

Marine Corps trains and executes Tactical Recovery of Aircraft and Personnel (TRAP)

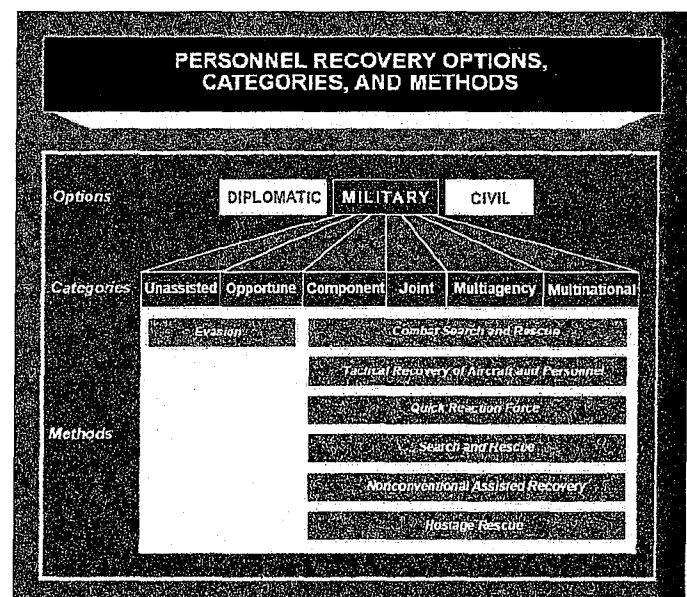


Figure 1: Categories of Personnel Recovery from Air Force Doctrine Document 2-1.6. Combat Search and Rescue (CSAR) is the method of choice for uncertain, denied, or hostile environments.

¹ (Henrickson 2007, 12)

² (Joint Chiefs of Staff 2007, I-1)

³ (United States Air Force 2005, 10) Joint Pub 3-50 details service responsibilities (Joint Chiefs of Staff 2007, II-2)

⁴ (United States Air Force 2005, 10)

missions, the Air Force is the only service to field dedicated forces with CSAR as their primary mission. This collection of specially trained active duty, National Guard, and reserve units carries the common title of Air Force Rescue or (more traditionally) Air Force CSAR. CSAR readiness commands a high priority within the Air Force; updating Air Force Rescue's entire fleet of HH-60 Pave Hawk helicopters continues to be a service priority.

During the past few years, the Marine Corps and Air Force Special Operations Command (AFSOC) have both fielded operational squadrons of V-22 Osprey tilt rotor aircraft. Revolutionary and controversial, the tilt rotor can take off like a helicopter and cruise like an airplane. The unique capabilities of the V-22 make it a useful tool for Marine assaults, special operations support, and potentially PR. Though initially considered to replace Air Force Rescue's Pave Hawk fleet, Bell-Boeing removed the V-22 from the competition in 2005.⁵ Despite this fact, the V-22 will play a central role in future PR and CSAR operations for several reasons. Dedicated CSAR assets, such as Air Force Rescue, cannot realistically protect every American serviceman in danger of becoming isolated. Because of their missions, Marines and SOF will both employ the V-22 in austere locations where it is arguably the best suited, or conceivably the only, PR option. In particular, AFSOC's CV-22 squadrons will inherit a historical and doctrinal responsibility for CSAR. Leaders within the V-22 communities and specifically those in AFSOC should embrace this challenge by recognizing important training opportunities and developing key relationships required for successful CSAR operations.

Development of the V-22: From Troubled Start to Combat Employment

⁵ (V-22 Bows Out of CSAR-X/PRV Competition 2005)

The rocky development of the V-22 has spanned more than 27 years. Initial plans for the Army, Navy, Air Force and Marines to purchase 1086 tiltrotor aircraft shrank gradually to the current order of 410 airframes; 360 for the Marine Corps and 50 for the Air Force.⁶ Since its inception in 1981, the program has cost the Department of Defense \$20 billion, fallen in and out of favor with policy makers, and sustained a series of fatal mishaps. As Secretary of Defense, Dick Cheney personally tried to cancel the program four times.⁷ In January 2001, the Navy and Marine Corps temporarily suspended production in the wake of a DOD investigation into falsification of maintenance records at the Marine



Figure 2: An Air Force Special Operations CV-22 Osprey Aircraft

Medium Tiltrotor Training Squadron (VMMT-204) in New River, North Carolina.⁸ Most tragically, accidents in 1992 and 2000 claimed the lives of thirty Marines and Boeing contractors.⁹ In 2001, the Commandant of the Marine Corps General James L. Jones wrote, "The experiences of the last year...have revealed that considerable work remains to be done in the areas of engineering and design, quality assurance, developmental testing, training, and operational evaluation."¹⁰ Haltingly, the program progressed through development towards combat employment. In fall 2007, on the eve of the Marines' first operational MV-22 deployment to Iraq, former Pentagon V-22 spokesman Ward Carroll arguably captured the mood

⁶ (Moyers 2007)

⁷ (Thompson 2007)

⁸ (James L. Jones 2001, 17)

⁹ (James L. Jones 2001, 47)

¹⁰ (James L. Jones 2001, 5)

of many in the Marine Corps when he told Time Magazine, "I'm still not convinced that the Marine ground pounders are in love with this airplane."¹¹

Despite its arduous inception, the V-22 has obtained operational capability. In September 2007, the first operational Marine MV-22 unit arrived in Iraq and began to deliberately execute a range of combat missions. In January 2008, V-22 advocate Loren Thompson, a defense analyst with the Lexington Institute, summarized that "The kind of harrowing operations that people anticipated haven't occurred so far, but what we're learning about the V-22 in Iraq is that it can operate every day, it can perform a wide range of missions, and - at least so far - it does not have deficient reliability," According to Marine reports, the MV-22 has performed a variety of successful missions to date including battlefield circulation, raid and aeroscout operations, and TRAP.¹²

For their part, the Air Force continues to push towards the deployment of its own version of the Osprey, the CV-22, for use with AFSOC. Demand for the CV-22 in the United States Central Command (CENTCOM) area of responsibility remains considerable. According to Lieutenant Colonel Theodore Corallo, the commander of AFSOC's first operational Osprey unit, the Air Force's CV-22 is scheduled to become operational in 2008 but United States Special Operations Command (USSOCOM) would like the capability as soon as possible. Pressure to deploy the CV-22 quickly stems partly from the imminent retirement of AFSOC's MH-53 Pave Low helicopters, whose insertion and extraction mission the Osprey will partly assume. According to Lieutenant General Michael Wooley, then commander of AFSOC, 2008 is a "firm

¹¹ (Thompson 2007)

¹² (Whittle 2008)

mark on the wall” for the MH-53 retirement, because the command will not buy spare parts to last beyond then.¹³

The CSAR-X/Personnel Rescue Vehicle competition

During the past several years, the Air Force has aggressively sought a replacement for its aging fleet of HH-60 Pave Hawk rescue helicopters. 101 Pave Hawks, together with 37 HC-130 “King Bird” aerial tankers and associated personnel form the backbone of the Air Force’s dedicated PR/CSAR force. Though young when compared to the MH-53 Pave Low, the Pave Hawks have faced acute performance limitations in areas such as speed, range, carrying capacity, and reliability that are evident in harsh environments such as Afghanistan and in Iraq. Improving the fleet is a service priority. “Combat search and rescue is a big deal for people like me,” explained Air Force Chief of Staff Michael Moseley, stating that the Air Force has a “moral and ethical imperative” to rescue the pilots and ground troops that venture into harm’s way—potentially hundreds of miles into hostile environments—in service of their country. Accordingly, the Air Force intends to field a combat ready squadron of new PR/CSAR helicopters by 2012 and a complete fleet by 2019.¹⁴ The competition for a new rescue vehicle has gained the enigmatic title “CSAR-X” or “Personnel Rescue Vehicle (PRV).”

From a capability standpoint, the V-22 at one time seemed a strong contender for the PR/CSAR role. In the critical areas of speed and range, the tiltrotor concept promised to eclipse the capabilities of any rotary wing competitor. However, on 20 October 2005 the Tilt Rotor Division of Bell Boeing announced that it would not submit a proposal for CSAR-X.

After thorough review of the revised Air Force request for proposal, it was clear that the CSAR-X program's requirements and funding profile did not call for the

¹³ (Hebert 2007)

¹⁴ (Sirak 2007)

advanced speed and range offered by the V-22 Osprey, and instead leaned toward capabilities found in more-traditional helicopter-type aircraft.¹⁵

The words “funding profile” certainly pointed to the V-22’s price tag, which at \$85 million¹⁶ per copy substantially exceeded the price of the other CSAR-X contenders and dwarfed the sticker price of an HH-60G.¹⁷ Some critics have questioned the ability of the Osprey to perform hoisting and insertion from a hover, citing the thrashing downwash produced by its small, and hence faster, twin rotors.¹⁸ Others highlight the inability of the aircraft to “autorotate” (settle slowly to the ground) in the event of a dual-engine failure.¹⁹

The CSAR-X competition remains unresolved. Although General Moseley announced that Boeing’s H-47 Chinook helicopter had won the selection on 9 November 2006,²⁰ protests from Lockheed Martin and Sikorsky prompted Congress’s Government Accounting Office (GAO) to overrule the decision. Presently, the race remains an open struggle between Boeing’s H-47 Chinook, Lockheed Martin’s US-101, and Sikorsky’s H-92 Superhawk (See Appendix One).²¹ While the process slowly continues, frustrations have mounted in the Air Force. As General Moseley stated in April 2007, “At the end of the day, we have to get a new helicopter.”²²

Evolution of the PR/CSAR mission

The PR/CSAR mission, though officially joint, has been adopted and refined almost exclusively by the Air Force, with a strong Special Operations flavor. PR/CSAR culture, often

¹⁵ (V-22 Bows Out of CSAR-X/PRV Competition 2005)

¹⁶ (Pittman 2008)

¹⁷ According to the Air Force, an HH-60G in 1998 cost \$9.3 million. (US Air Force 2007) According to a 2005 Defense Industry Daily article, A fully equipped HH-101 will cost “over \$50 million each”; Boeing’s MH-47G is “a \$40+ million aircraft” and the H-92 is a “\$50 million class machine.” (Defense Industry Daily 2005)

¹⁸ As a counter argument, according the Mr. Tom Green at AFSOC Weapons and Tactics, “Testing seems to validate the CV-22s ability as an AIE platform in hover stability during all [fast rope, rappel, and hoist] work. [fast rope insertions] to a building top remain somewhat problematic.”

¹⁹ (James L. Jones 2001, 49)

²⁰ (T. M. Moseley 2006)

²¹ (Defense Industry Daily 2008)

²² (Sirak 2007)

associated with daring raids into hostile territory, draws from the legendary exploits of the Air Rescue and Recovery Service (ARRS) in Vietnam. Today, the altruistic CSAR role remains close to the heart of Air Force leaders and operators. According to General Moseley in his "Chief of Staff of the Air Force's White Paper," dated 29 December 2007,

Soldiers, Sailors, Marines, and Coast Guardsmen share a sacred bond with Airmen: we will not leave a comrade behind. We are modernizing combat search and rescue forces to fulfill the moral imperative to locate, support and recover our joint warriors. The Air Force is committed to fielding a new combat search and rescue aircraft; advancing our rescue concepts of operation; and enhancing survival, evasion, resistance, and escape (SERE) training—all to ensure that the Air Force remains the premier combat search and rescue force for the entire joint team.²³

Every Year, well attended Jolly Green Reunions²⁴ recount stories like the rescue of "Boxer 22," an F-4 crewmember downed by enemy forces and stranded in Laos for three days during December 1969. Then as now, American forces expended every asset available to bring the isolated airman safely home. At the conclusion of the Boxer 22 rescue, twelve HH-3 and HH-53 rescue helicopters and twelve A-1E Sandy escort aircraft sustained battle damage, and one pararescueman lost his life to return the downed American.²⁵ By the end of the Vietnam conflict, the Air Force had lost twenty-nine helicopters to enemy fire but saved 4,120 lives and defined a proud culture.²⁶

In the early 1980s, many of the aircraft and personnel from the ARRS migrated to the nascent Air Force Special Operations Command, where they joined Special Operations Squadrons. 1982 also witnessed the inception of the Army's 160th Special Operations Air Regiment (SOAR), eventually task organized beneath U.S. Army Special Operations Command

²³ (M. Moseley 2007)

²⁴ The Jolly Green Giant cartoon character has endured as the official mascot for Air Force Rescue, featured on squadron patches and even naming two lines of Sikorsky helicopters, the HH-3 Jolly Green and the HH-53 Super Jolly Green (Air Force Special Operations History Office n.d.)

²⁵ (Tripp 1969)

²⁶ (United States Air Force 1998, 2) According to 1998 AFDD 2-1.6, 2780 of these were combat saves.

(USASOC).²⁷ Like the Air Force Special Operations flying squadrons, the 160th SOAR employed specialized helicopters capable of clandestine operations in denied areas. Both AFSOC and USASOC currently fall under the operational control of United States Special Operations Command (USSOCOM).

Though not technically rescue organizations, AFSOC and 160th SOAR units performed PR/CSAR missions during Operation Desert Storm for the Commander in Chief of CENTCOM. Their efforts met with both success and criticism. On 21 January 1991, an AFSOC MH-53 Pave Low helicopter escorted by two A-10 ground attack jets successfully rescued downed Navy F-14 pilot Lieutenant Devin Jones, earning the Pave Low aircraft commander accolades for the most meritorious flight of the year. During the same time, helicopters from the 160th SOAR rescued a compromised Special Forces A-Team from deep inside Iraq,²⁸ and later saved Air Force F-16 pilot Captain Scott Thomas.²⁹ In a less laudable event, downed American pilot Major Thomas E. Griffith and another crewmember spent three and a half frustrating days on the ground in Western Iraq after enemy forces brought down their fighter, only to be captured by the Iraqis. After his repatriation, Major Griffith wrote an impassioned position paper calling for the employment of dedicated rescue assets, not just SOF aircrews performing CSAR as a secondary role.³⁰ In 2001, the Deputy Commander of U.S. Joint Forces Command (USJFCOM) summarized PR/CSAR shortcomings during Desert Storm:

Out of the 38 aircraft lost, the coalition forces had 63 personnel isolated during the war. Only seven PR missions were launched and only three personnel recovered by PR forces. Twenty-five became POWs, one self-recovered by walking out, and the rest were killed in action. Not one rescue was accomplished inside the two-hour window used with great success during Vietnam...Other

²⁷ (Federal Research Division, Library of Congress 2001)

²⁸ (Moentmann, Holland and Wolver 1998, 45)

²⁹ (Federal Research Division, Library of Congress 2001)

³⁰ (Blumentritt 1999, 86)

significant problems included a lack of dedicated Combat Search and Rescue assets....³¹

The depleted ARRS, renamed the Air Rescue Service (ARS) in 1989, struggled to find its place during the 1990s. The service acquired new HH-60 Pave Hawks in the beginning of the decade but not quickly enough to deploy to Iraq for Desert Storm. In 1993, the ARS moved from Air Force Air Mobility Command to Air Combat Command (ACC), officially becoming Air Force Combat Search and Rescue.³² In 1996, the Secretary of Defense and the Air Force assigned ACC as the Department of Defense's Executive Agent for CSAR.³³ Despite the renamed organization's expanding capability, AFSOC continued to fill a combat rescue role during this period, sitting dedicated alerts for the JFC in Bosnia in 1995 and successfully rescuing two airmen downed during the Kosovo conflict in 1999.³⁴ For their part, the 160th SOAR completed deployments to Bosnia and Kuwait, and performed CSAR alert for Operations Desert Thunder and Desert Fox over Iraq in 1998-1999.³⁵ In June 1995, when Captain Scott O'Grady ejected from his stricken F-16 over Bosnia, a Marine Tactical Recovery of Aircraft and Personnel (TRAP) team utilizing forty Marine helicopters, fighters, and Air Force support aircraft successfully retrieved the downed airman.³⁶

On 3 October 1993, the 160th SOAR lost two MH-60 helicopters during the battle of Mogadishu in Somalia. The incident quickly escalated into a massive joint air and ground rescue effort, exclusively utilizing Special Operations units. The battle concluded with the death of

³¹ (Mayer 2001)

³² (Air Force Special Operations History Office n.d.)

³³ (Moentmann, Holland and Wolver 1998, 51)

³⁴ (McKinney and Ryan 2002, 179-192)

³⁵ (Federal Research Division, Library of Congress 2001) While no manned American aircraft went down during this period, the 160th SAOR did utilize their MH-47E aircraft to recover the wreckage of a downed Predator drone in 1999 during Operation Desert Fox.

³⁶ (McKinney and Ryan 2002, 159-165) According to Joint Forces Quarterly, Marines were used instead of SOF because "Marines were close and were the force of choice for daylight operations. Waiting for dark was ruled out because of the urgency of the situation." (Moentmann, Holland and Wolver 1998, 46)

eighteen Americans and 500 Somalis, witnessed the enemy capture of pilot Michael Durant, and prompted the withdrawal of American forces from Somalia.³⁷

During recent operations in Iraq and Afghanistan, Air Force CSAR has matured into a force more worthy of its proud heritage. Between December 2001 and June 2003 in Afghanistan, HH-60 crews completed 34 casualty evacuations (CASEVACs), three Searches and Rescue (SARs), and six CSARs. In June 2005, an HH-60 flown by Major Jeff Peterson rescued Marcus Luttrell, the sole survivor of a four man SEAL reconnaissance team engaged by the Taliban in Afghanistan.³⁸ Similarly, that organization flew 55 missions in Iraq and saved 73 lives (including the isolated pilot of a downed F-14) before the end of major combat operations in summer 2003.³⁹

Ironically, the Air Force CSAR community may have become a victim of its own success. Protection of forces demands dedicated CSAR assets to vigilantly wait, often accepting extended periods of inactivity. In his essay, "USAF Combat Search and Rescue: Untapped Combat Power," former Rescue Squadron Commander Lee dePalo described the experience of rescue forces in Iraq after their eleventh successful combat mission in 2003:

While this was not the most harrowing mission the unit executed, it was still very significant since it was the unit's last combat mission tasking for the next eight months. These low-density/high-demand (LD/HD) forces, whose members had rotated in support of the global war on terrorism (GWOT) continuously since the GWOT began, spent more than 200 straight days after executing the above mission without performing any missions other than training in the Iraqi theater. Many of these same individuals faced a similar situation when operating from Uzbekistan as part of the 46th Expeditionary Rescue Squadron (ERQS) in support of Operation Enduring Freedom (OEF) in 2002 and 2003. During this timeframe, the 46th ERQS launched only four missions in 16 months. All four occurred

³⁷ (Bowden 1997)

³⁸ (Blumenfeld 2007, A01)

³⁹ (DePalo 2005, 12)

within the first four months in-theater, with the unit continuing its deployment for the next year without a combat mission tasking.⁴⁰

On the tactical level, Air Force CSAR personnel feel the frustration of lengthy, empty deployments with few actual combat missions. Many, including dePalo, advocate an expanded role for the HH-60 and rescue forces beyond merely sitting alerts. Specifically, the rescue force might accomplish humanitarian missions or support other national objectives.

In 1999, HH-60 pilot Major John Blumentritt called for a reassignment of Air Force Rescue forces to SOCOM, in order to capitalize on the flexible nature of the rescue fleet and align it with the organization responsible for executing a majority of historical CSAR missions.⁴¹ This concept became a reality in 2003 when AFSOC assumed responsibility to train and equip many of the Air Force rescue assets, but reverted back to ACC in February of 2006. According to General Moseley, "Under ACC, the CSAR assets can be mobilized faster during a national crisis, integrated into combat training, and tasked to support all [Air and Space Expeditionary Force] rotations."⁴²

For the time being, Air Force CSAR has carved an effective niche within the operational structure. Strong support from the Air Force Chief of Staff, recent accolades, and an impending infusion of new aircraft promise to keep the organization relevant into the near future. Whether this trend will continue remains unclear. Effective CSAR coverage tasks a lot of expensive helicopters, aerial tankers, crews, and pararescuemen (PJs) to sit and wait. Subsequently, when military leaders must make tough decisions to allocate resources to win wars, rescue forces often

⁴⁰ (DePalo 2005, 1)

⁴¹ (Blumentritt, *Playing Defense and Offense: Employing Rescue Resources as Offensive Weapons* 1999, 1)

⁴² (M. Sirak 2006)

take a back seat. In a 1999 thesis for the Air Force School of Advanced Airpower Studies, HH-60 pilot John Blumentritt describes this issue:

...history documents that the combat search and rescue philosophy tends to be fiscally popular during transient anomalies, characterized by robust spending, a casualty averse environment, and limited threats that do not seriously threaten US national security. However, when US policy makers meet credible threats, or must contend with tight budgets, they tend to direct their efforts away from this altruistic mission. This has led to a fluctuating combat search and rescue commitment, and thus a decreased capability to consistently save downed pilots and crewmembers.⁴³

Current PR/CSAR Doctrine

Though General Moseley and others view the Air Force as the “premier combat search and rescue force for the entire joint team,”⁴⁴ responsibility for PR/CSAR remains an individual service responsibility, coordinated by United States Joint Forces Command (USJFCOM). Joint Publication 3-50, Personnel Recovery, describes the service’s responsibilities to maintain PR capability:

The services and United States Special Operations Command (USSOCOM) are responsible to prepare and present forces to the geographic combatant commanders that are organized, trained, and equipped to perform PR tasks consistent with the roles and functions established in law and by the President and [the Secretary of Defense] and the missions specified by the [Joint Force Commander].⁴⁵

Joint doctrine recognizes inherent PR recovery capabilities within each of the services. Army ground forces, Navy ships and helicopters, Marine ground and air assets, and Coast Guard cutters and aircraft all provide potential recovery assets.⁴⁶ In October 1999, Defense Reorganization Initiative Directive #29 transferred Executive Agent status for Personnel Recovery from the Secretary of the Air Force to the Commander of USJFCOM. The initiative

⁴³ (Blumentritt, *Playing Defense and Offense: Employing Rescue Resources as Offensive Weapons* 1999, x)

⁴⁴ (M. Moseley 2007)

⁴⁵ (Joint Chiefs of Staff 2007, xi)

⁴⁶ (Joint Chiefs of Staff 2007, B1-G5)

also prompted the creation of the Joint Personnel Recovery Agency (JPRA). According to Rear Admiral Martin J. Mayer, then Deputy Commander of USJFCOM, “[the JPRA brings] together the Joint Services SERE (Survival, Evasion, Resistance, and Escape) Agency, the Joint Combat Rescue Agency and the Joint CSAR Joint Test and Evaluation legacy products into a single entity...JPRA represents one stop shopping for Personnel Recovery expertise.”⁴⁷

Joint doctrine identifies specific CSAR responsibilities for several services, including the Navy. According to Joint Publication 3-50, appendix C (Naval Personnel Recovery):

[recovery of] isolated personnel located in low or medium anti-air threat areas...[is] assigned to [Naval] units specialized in CSAR. Traditionally, CSAR assets have been trained and equipped to rescue forces most likely to be isolated during combat, including downed aviators and distressed SOF.⁴⁸

To accomplish CSAR missions, the Navy utilizes carrier-based antisubmarine helicopter (HS) squadrons, sea combat helicopter (HSC) squadrons, or Combat Support Special (HCS) Squadrons operating HH-60H and MH-60H aircraft. Members of the Navy’s HCS Squadrons performed CSAR alert in Saudi Arabia during Operation Desert Storm, and integrated with SOF air units for Operation Iraqi Freedom.⁴⁹ The service is presently upgrading their helicopter squadrons to the more capable MH-60S Knighthawk.⁵⁰

⁴⁷ (Mayer 2001)

⁴⁸ (Joint Chiefs of Staff 2007, C-1)

⁴⁹ (Rye 2003) Specifically, the Red Wolves and Fire Hawks from HCS-4 and HCS-5

⁵⁰ (Joint Chiefs of Staff 2007, C-4) According to naval-technology.com, as of 2007, 132 MH-60S aircraft had been ordered and over 100 aircraft have been delivered. All 237 aircraft are scheduled to be in service by 2011. CSAR specific equipment includes a digital map, AN/AAS-44 FLIR, the electronic warfare self-defense suite, an additional pylon to carry Hellfire air-to-surface missiles and mk54 digital torpedo, and crew-served weapons. (Naval-technology.com 2007)

For their part, Marine Corps aviation forces train for and execute TRAP missions. TRAP missions are similar to CSAR missions but officially distinct.⁵¹ According to Joint Publication 3-50,

The TRAP mission differs from CSAR in that it usually does not involve extended visual search procedures to locate isolated personnel, particularly in a medium or high threat environment. TRAP assets may also be employed in the conduct of other [non-recovery] missions, and called upon to perform a recovery as it becomes necessary. The TRAP concept emphasizes detailed planning and the use of assigned and briefed personnel for the specific purpose of recovering personnel and/or aircraft.

The publication further stipulates that Marine forces should be prepared to conduct self-supporting recovery operations and also “provide mutual support to PR operations of other joint force components to the greatest extent possible.”⁵²

The Army does not doctrinally accept a CSAR role, although they recognize that aviation assets can perform a similar mission. According to JP 3-50,

Army aviation units are capable of rapidly recovering isolated personnel over extended distances compared to Army ground forces. However, they are usually general support forces and not intended to be used in prolonged or dedicated use such as USAF/US Navy (USN) CSAR task forces (CSARTFs). Army aviation units can task organize similar to a CSARTF, but they do not possess the same capabilities.⁵³

In a recent example during operations in Iraq, Army helicopter-borne Disaster Assistance and Response (DART) teams shadowed AH-64 attack helicopters to provide immediate rescue if needed.⁵⁴

Air Force CSAR assets provide the Joint Force Commander with a dedicated PR/CSAR capability. According to joint doctrine,

⁵¹ The differences between CSAR and TRAP are arguably semantic. As Mr. Tom Green pointed out, CSAR assets rarely perform extended visual search patterns, particularly in a high threat environment. Additionally, modern CSAR missions often feature dedicated planning and integrated CSAR task forces.

⁵² (Joint Chiefs of Staff 2007, D-1)

⁵³ (Joint Chiefs of Staff 2007, B-12)

⁵⁴ (Whitcomb 2005)

The unique makeup of ACC rescue squadrons and other ACC units provide geographic [component commanders] a small-footprint package of efficient, full-spectrum PR capability across the range of military operations. A geographic [component commander] can also request a scalable/tailored package to suit a specific capability requirement.⁵⁵

The Air Force is the only service to develop, train, and employ air and ground assets dedicated to PR and CSAR. In addition to HH-60 helicopters and HC-130 tankers, the service fields recovery teams consisting of Combat Rescue Officers (CROs), pararescuemen, and Survival, Evasion, Resistance, and Escape (SERE) specialists. These personnel are specially trained to assist or conduct PR operations from initial training through reintegration.⁵⁶

At present, Air Force PR/CSAR doctrine remains in flux. The current Air Force PR document, Air Force Doctrine Document (AFDD) 2-1.6 Personnel Recovery Operations carries a date of June 1st, 2005, during which time Air Force Special Operations trained and equipped many of the Air Force Rescue units. Not surprisingly, the document draws a strong connection between Air Force Rescue and Air Force Special Operations.⁵⁷ Though Air Force Rescue and AFSOC split in February 2006, the Air Force has not updated the document. Subsequently, the full effect of the realignment on Air Force Doctrine remains to be seen.

For its part, the 2007 Joint Publication 3-50 acknowledges the capability and heritage of SOF PR, but emphasizes that the mission is clearly secondary:

Each joint force component is responsible for performing PR in support of its own operations. As such, SOF regularly train to conduct PR functions in support of their own operations. When specifically tasked, SOF may perform PR for other members of the joint force. It is important for commanders to be aware, however, that unlike some other joint force components, SOF do not maintain dedicated PR forces. Since PR taskings often involve forces being placed on alert status awaiting mission execution orders, such taskings would be at the expense of the

⁵⁵ (Joint Chiefs of Staff 2007, F-2)

⁵⁶ (Joint Chiefs of Staff 2007, F-6) Recovery teams are known as the GUARDIAN ANGEL weapon system

⁵⁷ (United States Air Force 2005, 13)

SOF's ability to perform their core tasks. Therefore, greatest utility of SOF to the conduct of PR is in the conduct of SOF recovery operations....⁵⁸

Culturally, SOF aircrews do not appreciate long alerts any more than Air Force rescue crews. For SOF leaders, dedicating their air assets to CSAR alert reduces sorties available to support SOF ground teams.

A CSAR Role for the V-22

As the V-22 enters operational service, several factors foreshadow its employment as a PR/CSAR platform. The unique capabilities of the aircraft, particularly range and speed, qualify it for the role. Air Force CSAR assets, though well equipped and dedicated to PR and CSAR, cannot adequately cover every American soldier, sailor, and airman in danger of becoming isolated. For the Marines, accustomed to operating as an autonomous Marine Air Ground Task Force (MAGTF), MV-22s represent the bulk of assets available to perform TRAP. Like the Marines, Special Operations Forces often operate autonomously; and within SOCOM, AFSOC forces traditionally and doctrinally provide CSAR capability.

More than any rotary wing aircraft, the tilt-rotor embodies the quality of speed. CSAR advocates often focus on the "golden hour," after which the chances of a successful rescue decline considerably. Statistically, at the four hour mark, the chances of success dwindle at about 20 percent, with exposure, injuries, and enemy action all combining to seriously threaten an isolated airman's survival.⁵⁹ In airplane mode, the Osprey can cruise at 250 knots,⁶⁰ approximately twice that of an HH-60 Pave Hawk. It can penetrate swiftly into enemy territory, retrieve an isolated soldier, sailor, or airman, then deliver him to medical facilities or return him to his unit faster than any helicopter.

⁵⁸ (Joint Chiefs of Staff 2007, G-1)

⁵⁹ (United States Air Force 2000)

⁶⁰ (James L. Jones 2001, 43)

In addition to speed, V-22s enjoy a 503 mile unrefueled combat radius,⁶¹ roughly twice that of an HH-60 or MH-53 Pave Low. Like the HH-60 and MH-53, the V-22 can refuel in flight, but its superior range makes it much less dependent on aerial tankers. In some instances, a lack of refueling options could render the V-22 the only aircraft capable of rescuing another downed V-22. The Osprey payload area, while smaller than an MH-53, seats 18 combat loaded troops, and is substantially larger than the cramped rear cabin of the HH-60.⁶²

Other qualities make the Air Force CV-22 a particularly attractive CSAR recovery vehicle. Advanced avionics substantially improve the situational awareness of the crew, and a terrain following radar supports adverse weather operations. Unlike the Marine MV-22, the CV-22 flight crew includes a flight engineer who helps distribute the crew's workload during high stress situations, such as CSAR event.⁶³

Survivability of the aircraft remains controversial. Though both the CV-22 and the MV-22 can glide like airplanes and can distribute power to both rotor systems from one operating engine, the autorotative capacity of the aircraft in helicopter mode remains a serious concern. In the event of a dual engine failure, the V-22 settles much faster than a normal helicopter, making autorotational descent and landing extremely difficult. The Air Force and Marine Corps have essentially assumed this risk, foregoing future testing because of the "potentially high risk of losing the aircraft test asset."⁶⁴ Bell Boeing Engineers strove to decrease the vulnerability of the V-22 in a number of other ways; the aircraft features a large percentage of ballistic resistance composite materials, redundant systems (such as the mission computer), and a fly-by wire

⁶¹ (James L. Jones 2001, 43)

⁶² (Currie 1999, 26) Working space is a critical consideration for medical personnel, particularly with multiple injured personnel requiring stretchers.

⁶³ (James L. Jones 2001, 43)

⁶⁴ (James L. Jones 2001, 77)

control system that reduces vulnerable control linkages. Additionally, the Air Force CV-22 incorporates a full suite of defensive systems designed to defeat surface to air missiles.⁶⁵

Both the Air Force and Marine Corps recognize a deficiency in defensive weapons. For the Marines in particular, the MV-22 flies outflies the slower Marine UH-1 and AH-1 helicopters normally tasked to provide armed escort during an assault. To make matters worse, both the MV-22 and CV-22 wield a single tail mounted machine gun and no door guns, unlike the CH-46 or MH-53 helicopters. The thought of taking a troop loaded V-22 without helicopter escorts into a combat landing zone armed with only a tail gun concerns leaders within both services, particularly given the aircraft's limited ability to autorotate. According to Marine Corps pilot Major Jesse A. Janay in the *Marine Gazette*, "The Issue of the MV-22's self-defense weapon is a recognized tactical shortfall."⁶⁶ In the words of Marine Lieutenant General John G. Castellaw, Deputy Commandant of the Marine Corps for Programs and Resources,

I'm a -46 pilot...the main reason I got .50 [caliber machine guns] that are on either side is when I go into the zone, because I'm so slow and my acceleration rate is just a little bit better than a Volkswagen, then I want something that's going to keep their heads down until I get enough speed and get away from there.⁶⁷

Currently, both the Air Force and Marine Corps are developing a short range (7.62mm) belly mounted turret gun to provide a measure of defensive fire.⁶⁸

Though Air Force CSAR forces continue to grow in capability, they cannot realistically provide PR coverage for more than a few strategic areas. American forces deployed in small

⁶⁵ (Currie 1999, 26)

⁶⁶ (Jannay 2008, 19-20)

⁶⁷ (Schogol 2007)

⁶⁸ (Business Press International 2008) According to BAE systems, "The U. S. Special Operations Command -- SOCOM -- which awarded the contract to integrate and test the weapon mission kit on the CV-22, is currently performing ground testing, with flight testing to follow. SOCOM oversaw the successful installation of the system hardware aboard the aircraft in January at Hurlburt Field, Florida."

concentrations, including Marine Expeditionary Units and Special Operations Task Forces, will likely have to provide their own PR/CSAR capability or obtain it through other means.

During large operational deployments, Joint Commanders have to make critical decisions on which forces to deploy first, and Air Force CSAR assets may prove less essential for initial airlift packages than strike assets and maneuver forces. The moral obligation to rescue isolated servicemen is undeniably strong, but CSAR can be performed by a variety of other forces ad-hoc until dedicated CSAR forces arrive if commanders are willing to accept some risk. This was the case during the opening weeks of Operation Enduring Freedom, when AFSOC MH-53 helicopters provided PR/CSAR support until primary CSAR forces stood up.⁶⁹

Even with dedicated CSAR forces available, other units have filled the role. Such was the case with the Marine TRAP mission in 1995 to rescue Captain O'Grady despite the presence of CSAR-trained SOF. Similarly, On 19 October 2001, Marine helicopter crews from the *USS Peleliue* supporting Operation Enduring Freedom attempted a CSAR mission to rescue the survivors of a downed Army UH-60 on the border of Afghanistan and Pakistan. Initially turned back by enemy fire, they later returned and retrieved the survivors.⁷⁰

For the Marines, MV-22s represent the bulk of air assets available to perform TRAP. Marine CH-53 helicopters have traditionally filled the roll, but MV-22s will soon outnumber the entire fleet of CH-53's by two to one.⁷¹ Correspondingly, the current MV-22 flight manual reflects the TRAP mission as an important auxiliary role.⁷² Unlike SOF aviation units, Marines

⁶⁹ (Project on Government Oversight 2007) According to a RAND report, Air Force HH-60 Pave Hawks arrived in Uzbekistan on October 7, 2001, the same day the bombing campaign began. AFSOC MH-53s had been in Jacobabad, Pakistan since September 22. (Lambeth 2005, 69)

⁷⁰ (Lambeth 2005, 111)

⁷¹ (naval-technology.com 2007) According to naval-technology.com, the Marines require 156 CH-53K's by 2012.

⁷² (United States Marine Corps 2007, 1-4) The MV-22 T&R manual includes the roles, "Conduct Tactical Recovery of Aircraft and Personnel (TRAP) operations, Augment local Search and Rescue (SAR) assets, [and] Provide support for evacuation operations."

do not customarily provide dedicated CSAR assets for the Joint Force Commander, focusing almost exclusively on the needs of the Marine Air Ground Task Force (MAGTF).

Like the Marine Corps, SOF often operate autonomously. Unlike the Marines, they have regularly accepted responsibility for providing dedicated CSAR capability to the Joint Force Commander through the Combined/Joint Forces Air Component Commander (C/JFACC). Within SOCOM, AFSOC acts as the executive agent for CSAR and traditionally supplies aircraft and personnel for the mission, whether to the SOF commander or the overall Joint Force Commander.⁷³ In addition to aircraft like the MH-53 and CV-22, AFSOC controls its own Special Tactics Squadrons, employing elite pararescuemen. As CV-22's continue to arrive in AFSOC squadrons, those units will inherit a traditional and doctrinal responsibility for CSAR, despite ongoing CSAR-X initiatives.

Recommendations

Leaders within the AFSOC CV-22 community, and their Marine brethren to a lesser extent, will face direct challenges to prepare and execute successful PR/CSAR operations. For Air Force leaders, much of this responsibility will fall within the context of SOF specific operations. However, they should not dismiss the possibility of an occasional or even regular operational relationship with the C/JFACC. With that in mind, there are several important things they should do. First, they should leverage peacetime Search and Rescue (SAR) opportunities and CSAR exercises (CSAREX) to build skills and identify problems. Second, they should work diligently to build training relationships, particularly with dedicated rescue assets, the Joint Personnel Recovery Center (JPRC), and organizations with similar capabilities.

⁷³ (Olson 2007, para 5c)

Peacetime Search and Rescue

Aside from altruistic benefits, participating in peacetime Search and Rescue (SAR) helps to prepare Special Operations aircrews for more challenging CSAR operations. First, such activities should be used develop training relationships with recovery team members who might later serve during a CSAR event. Second, peacetime SAR events represent a rare opportunity to experience many of the challenging elements inherent in CSAR. Civilian SAR is often executed under short notice, planned under pressure, and highly stressful. Such missions force Special Operators out of their comfort zone.

CSAR Exercises

Air Force Doctrine provides general guidance on CSAR exercises, emphasizing the complex nature of operations and recommending a comprehensive approach:

The focus should be on exercising the system as a whole, including the Joint Forces Air Component Commander (JFACC) and the Air Operations Center (AOC), the Personnel Recovery Coordination Center (PRCC), elements of the CSAR Task Force (CSARTF), Air Mission Commander (AMC), On Scene Commander (OSC), and the isolated personnel.⁷⁴

Such all-inclusive training opportunities are expensive and rare, particularly for SOF that practice CSAR as a secondary mission. However, opportunities exist and leaders within the CV-22 community should pursue them.

One potential opportunity is to construct CSAR scenarios into existing Special Operations exercises. Many large exercises already include many of the elements of a CSARTF, including Airborne Warning and Control System (AWACS), fighters, and aerial refuelers. Some of the assets (such as A-10 ground attack aircraft) maintain training requirements in CSAR skill sets. Smaller exercises provide an opportunity to practice particular skill sets, such as authentication of isolated personnel, rapid planning, and isolated personnel location.

⁷⁴ (United States Air Force 2005, 24)

A second opportunity involves integrating AFSOC aircraft into existing ACC exercises. As an example, on 18 July 2007, Davis Monthan Air Force Base hosted "Angel Thunder", a national level CSAR exercise that integrated multiple airframes and utilized an entire CSARTF. According to an Air Force press release, the exercise was "the first...interagency, Department of Defense, and Department of Justice joint CSAR training ever conducted."⁷⁵ Similarly, exercise "Red Flag Alaska" in July 2007 staged a complex rescue scenario in the middle of a 6 nation, 1500 personnel event.⁷⁶ Such events provide realistic training and stress in a challenging, unfamiliar environment.

A Role in the Personnel Recovery Coordination Cell (PRCC)

One way that CV-22 operators can maintain CSAR proficiency and exercise relationships with the C/JFACC is to integrate into the Personnel Recovery Coordination Cell (PRCC). Standing PRCC's plan and coordinate CSAR readiness within the Joint Forces Air Component (JFAC) Air Operations Center (AOC), then become the central controlling agent for rescue assets in the event of an actual CSAR event. Similarly, at the Combatant Commander or JFC level, the Joint Personnel Recovery Center (JPRC) acts as the center for all PR actions within the commander's area of responsibility.⁷⁷ According to Air Force Doctrine, "the PRCC is the hub of Air Force PRO activities."⁷⁸ Though traditionally staffed and run by rescue personnel, staffing in the PRCC is by no means limited, and open to members of the SOF community. Such a position develops important channels between special operations crews and the rescue process, as well as providing experience for the operator.

⁷⁵ (Copeland 2007)

⁷⁶ (Jones 2007)

⁷⁷ (Joint Chiefs of Staff 2007, II-7)

⁷⁸ (United States Air Force 2005, 11)

Training Relationships

Ideally, Air Force CV-22 leaders should seek to develop training relationships with anyone who might serve on a CSAR Task Force (CSARTF). CSARTFs are often complex, combining all of the aircraft and resources needed to successfully complete a bold, time sensitive operation. According to Air Force Doctrine,

Since the Vietnam War, Air Force personnel recovery efforts have been combined into a tailored CSARTF – a proven mechanism that has significantly enhanced CSAR operations. The size and complexity of the CSARTF has depended on the mission requirements and the threat.⁷⁹

CSARTFs may include recovery teams, an Airborne Mission Commander (AMC), Rescue Escort Assets (RESCORT), an On Scene Commander (OSC), Close Air Support (CAS) assets, aerial tankers, Intelligence Surveillance and Reconnaissance (ISR), Space systems, and Suppression of Enemy Air Defense (SEAD) assets.⁸⁰

Luckily, many of these organizations train with Air Force Special Operations Forces (AFSOF) on a regular basis to maintain currency on Special Operations missions. On the list of CSARTF members, recovery team members (Combat Rescue Officers [CRO], Pararescuemen [PJs], and Survival Evasion Resistance and Escape [SERE] specialists) are arguably the most crucial. No other group can better integrate CV-22 operators into the CSAR mechanism and insure success. According to Air Force Doctrine, “CRO/SERE specialists provide specific expertise in the report, locate, support, and reintegrate tasks when attached to operational squadrons, component PRCC, or the theater JPRC...CRO/PJs provide the critical air to ground link between airborne rescue platforms and isolated personnel.”⁸¹

⁷⁹ (United States Air Force 2005, 12)

⁸⁰ (United States Air Force 2005, 16)

⁸¹ (United States Air Force 2005, 14)

Integration with Similar Organizations

The Marine Corps and Air Force Special Operations have a lot to learn from each other about PR and CSAR. The Marines, with 360 airframes, will quickly accumulate a wealth of operational data concerning the V-22. The Air Force, more closely tied to the CSAR mission, will have more specialized information on the subject. Crosstalk, crewmember exchanges, and joint operations will serve to synergize knowledge on the subject.

Conclusion

The CSAR future of the V-22, particularly for AFSOC V-22 Squadrons, is not only bright but looming. Leaders within the V-22 community stand at the center of a confluence of forces that will drive employment of the tilt rotor aircraft towards the altruistic mission. More than ever, Joint Force Commanders demand an effective PR capability to hedge against the moral and strategic cost of a captured airman or an isolated soldier. The V-22 offers the capability to reach quickly and deeply into denied territory; arguably better than any other rescue system. Because V-22s accompany Marines and SOF, they will be the first to deploy during major combat operations. Likewise, when Marines and SOF deploy for small operations, their organic V-22s may be the only vertical-lift assets available. Within AFSOC, CV-22 operators inherit a proud culture for CSAR with roots in Vietnam. The command has a long tradition of CSAR service to the JFC and the C/JFACC, as well as a doctrinal responsibility to SOCOM. AFSOC also operates its own pararescuemen. For their part, the dedicated Air Force Rescue units cannot adequately protect every soldier, sailor, and airman in danger of becoming isolated. Personnel Recovery is, doctrinally and necessarily, a joint responsibility and commanders must ultimately leverage the unique capabilities contained in their particular force to insure the protection of their troops. In many cases, the V-22 will be the Joint Force Commander's best or

only CSAR option. Leaders within the V-22 community should embrace this challenge, recognize training opportunities and develop key relationships required for successful CSAR operations.

Appendix 1: CSAR-X competitors

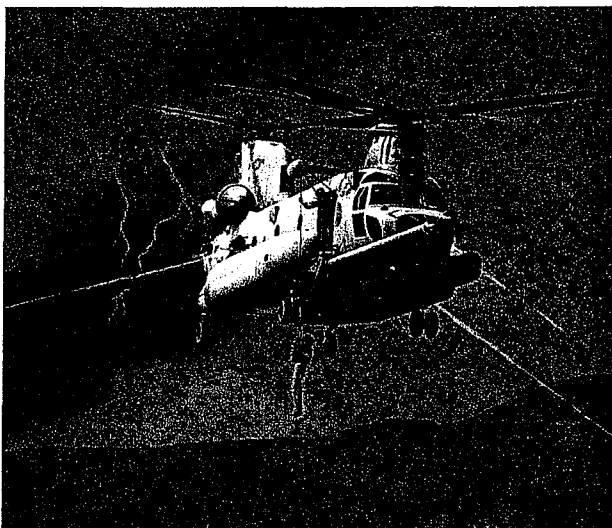


Figure 3: Boeing's H-47 Chinook CSAR helicopter
http://www.defenseindustrydaily.com/images/AIR_HH-47_Concept_lg.jpg



Figure 4: Sikorsky's H-92 "Superhawk" CSAR helicopter **<http://www.airforce-technology.com/projects/superhawk/superhawk4.html>**



Figure 5: Lockheed Martin's EH-101 (A close variant of the proposed US-101)
http://www.defenseindustrydaily.com/images/AIR_CH-149_Cormorant_lg.jpg

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